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Sean Eom

Southeast Missouri State University, sbeom@semo.edu

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The Determinants of Web-based Instructional Systems' Outcome: A Step-wise regression approach

Sean Eom

Southeast Missouri State University
sbeom@semo.edu

ABSTRACT

Post-secondary distance education via the Internet is now a commonplace. Tremendous advances in Information Technology have allowed colleges and universities to offer Web-based courses as a way to meet the growing demand for educational experiences from those who, because of distance from campus or scheduling conflicts, would otherwise not be able to take courses. This paper develops a model explaining the relationship between a dependent variable (the perceived student's learning outcome) and six independent factor variables using a step-wise regression approach.. The findings indicate that the instructor's personal attention to individual students in regard to individual learning, overall usability of the course website, students' self-motivation toward web-based courses, the instructor's role in facilitating the learning process, and clearly defined course objectives and procedures have a strong impact on the learning outcomes of e-learning systems.

Keywords

Distance Education/Distance Learning, Asynchronous Education, Learning Effectiveness, Perceived Learning Outcomes, Students Satisfaction, step-wise regression.

INTRODUCTION

The landscape of distance education is changing. This change is being driven by the growing acceptance and popularity of online course offerings and complete online degree programs at universities. U.S. News and World Report recently reported that "70 percent of American universities have put at least one course online, and by 2005 that may grow to 90 percent" (Shea and Boser, 2001, p.44). Further, the growth of 'distance learning' programs gives students a wider choice of schools without regard to location. The trend towards more online offerings is being exhibited internationally.

The primary objective of this study is to determine what are the critical factors (independent variables) that influence learning outcomes of online courses (dependent variables). This research helps educators manage the critical factors to maximize the greatest positive impact on learning outcomes.

RESEARCH MODEL

Many factors can affect the perceived satisfaction and learning outcome of the students who take Web-based courses. The distance learning system can be viewed as having several human entities interacting together via computer-based instructional systems to achieve the goals of the system. We conducted a literature survey focusing on those variables that might affect the outcome of a Web-based course such as the perceived student satisfaction and learning outcome (Eom, et al., 2004). Based on the survey of literature, we constructed the research model as shown in Figure 1, based on the review of many prior studies (Alavi, 1994; Alavi, et al., 1995; Clow, 1999; Graham and Scarborough, 2001; Jiang and Ting, 2000; Piccoli, et al., 2001; Swan, 2001; Wolfram, 1994). There is much research seeking to identify the factors that contribute to the success of online course delivery systems. All of these studies seem to agree that these two dependent variables measure the effectiveness of online education systems.

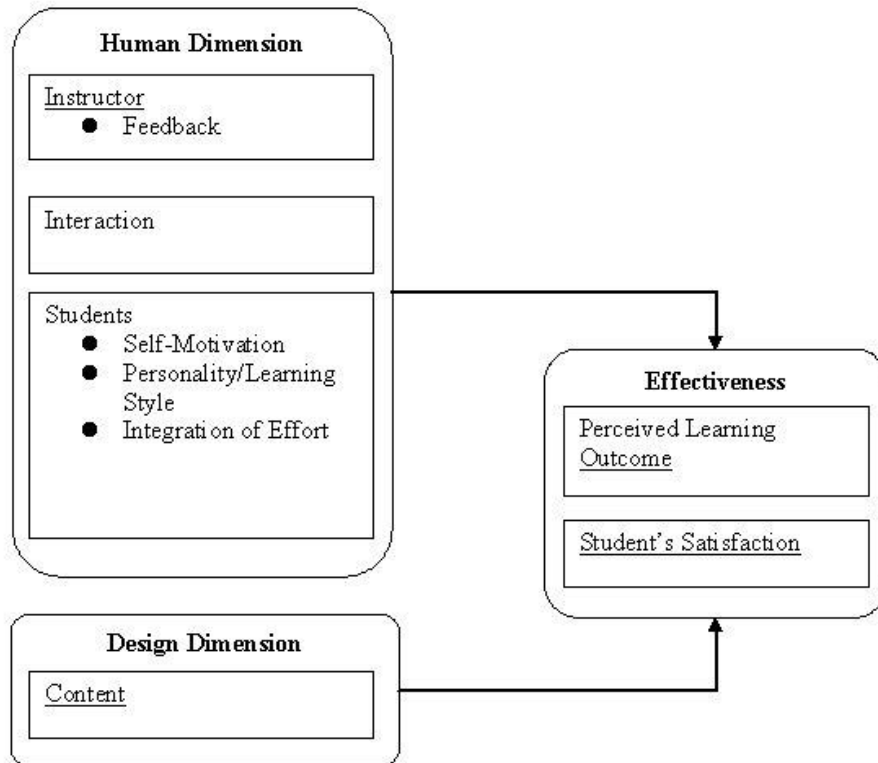


Figure 1. Research Model

DATA AND RESEARCH METHOD

After conducting an extensive literature review as already discussed, we designed a list of questions that we believed were logically associated to the factors in our model. For a complete list of the actual administered survey questions please refer to Appendix A. Questions 10-28 and 30-39 comprised the Likert-scale question set utilized for our study. Appendix 1 shows that the questionnaire contains 17 independent variables, 4 user satisfaction variables, and 4 learning outcomes variables. This study focuses on the modeling the determinants of the learning outcomes using a step-wise linear regression approach. In an effort to survey students using technology enhanced teaching tools, we focused on students enrolled in online (Web-based courses). We collected email addresses from the student data file archived with every online courses delivered. From these lists, we generated an original target group of 2,131 unique e-mail addresses. Valid unduplicated responses numbered 408, for an overall response rate of 22.0% of valid addresses.

Step-wise multiple linear regression in SPSS program is used to analyze the dataset collected. The stepwise regression program determines which variables among the specified set of independent variables (17 variables) will actually be used for the regression, and in which order they will be introduced, beginning with the forced variables and continuing with the other variables one by one. After each step the algorithm selects from the remaining independent variables the variable which yields the largest reduction in the residual (unexplained) variance of the dependent variable (Question 31), unless its contribution to the total F-ratio for the regression remains below a specified threshold.

RESULTS

The step-wise linear regression produced a set of models that successively include the most significant variable one-by-one to yield the largest reduction in the un-explained variances of the dependent variables. Table 1 shows 8 different models. Model 1 includes only one variable (Q16), which explains 37% of variances. Model 2 added one more variable (Q30) and thereby reduces the unexplained variance of the dependent variables by approximately 10%. The magnitude of the marginal

impact of adding an independent variable on the R-square values is decreasing successively. The last two variable introduced in model 8 reduced only .004% of residual variance of dependent variable.

Model Summaryⁱ

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.608 ^a	.370	.368	1.024
2	.687 ^b	.473	.470	.938
3	.735 ^c	.541	.537	.877
4	.747 ^d	.559	.554	.861
5	.755 ^e	.569	.563	.851
6	.760 ^f	.578	.571	.844
7	.764 ^g	.583	.575	.840
8	.767 ^h	.588	.579	.836

a. Predictors: (Constant), Q16

b. Predictors: (Constant), Q16, Q30

c. Predictors: (Constant), Q16, Q30, Q33

d. Predictors: (Constant), Q16, Q30, Q33, Q11

e. Predictors: (Constant), Q16, Q30, Q33, Q11, Q19

f. Predictors: (Constant), Q16, Q30, Q33, Q11, Q19, Q34

g. Predictors: (Constant), Q16, Q30, Q33, Q11, Q19, Q34, Q14

h. Predictors: (Constant), Q16, Q30, Q33, Q11, Q19, Q34, Q14, Q12

i. Dependent Variable: Q31

Table 1. Model Summary

Table 2 shows each independent variable's beta coefficient and their corresponding t-value. All t-values are significant.

Variables	Unstandardized Coefficients (B)	Unstandardized Coefficients (Std. error)	Standardized Coefficients	T	Sig.
Constant	-2.014	.276		-7.28	.000
Q16	.238	.065	.206	3.693	.000
Q30	.363	.068	.236	5.315	.000
Q33	.284	.045	.231	6.264	.000
Q11	.222	.070	.176	3.179	.002
Q19	.210	.066	.154	3.198	.002
Q34	.098	.044	.084	2.247	.025
Q14	.119	.054	.099	2.195	.029
Q12	-.107	.053	-0.96	-2.02	.043

Table 2. Coefficients

INSTRUCTOR

Our survey questionnaire included several questions in regard to the instructor's knowledge (Q10), instructor's role as a facilitator in the learning process (Q11) and as a stimulator to students' intellectual efforts (Q17), instructor's expectation of students responsibility for learning (Q15), and instructor's caring attitude toward individual learning (Q16). Our study concluded that instructor's caring attitudes (Q16) and role as the facilitator (Q11) are strongly correlated with perceived learning outcomes. The instructors caring attitude toward students' individual learning can be exhibited by many different ways. Instructor feedback in the Web-based system can include replies to student e-mails, graded work, and synchronous commentary, as might be conveyed through chatrooms or conferencing software. We believe that high levels of quality feedback will lead to increased levels of integration use, thus enhancing the connection between these factors and our outcome factors.

Graham and Scarborough's study (2001, p. 238), which consisted extensively of interviews, collected many comments about feedback, both positive and negative. They found that "55.5% felt the feedback received enhanced their learning."

Course Content

Content is an essential part of the learning environment. Content refers to the graded course requirements rather than the topics covered in the course, and it includes all learning events and resources from the World Wide Web. It may include

- examinations (Lois, 2001)
- cases (Lois, 2001; Wang, 2002) and discussion (Carpenter, 1998; McClenahan, 1997; Phillips, 1998; Wang, 2002)
- team-prepared written assignments (Lois, 2001; Wang, 2002)
- presentations (Atwon, 1997; Lois, 2001; Wang, 2002)
- team-based simulations (Lois, 2001; Wang, 2002)

Swan (2001) conducted a study involving 73 courses from State University of New York Learning Network in the Spring of 1999. The courses collectively enrolled almost 400,000 students, and involved 64 related institutions. The study attempted to associate factors that affected student satisfaction with perceived learning in an asynchronous online learning environment. Her empirical study discovered that there were significant relationships between student perceptions and course design.

Swan's conclusions about the relationship between content structure, student satisfaction, and perceived learning are supported by Dembo & Eaton's report that appears to link learning style to the manner in which material is organized. In fact, the general belief is that it is extremely difficult, and perhaps impossible, "for humans to learn unorganized bits and pieces of information without imposing patterns of organization on the information" (Dembo and Eaton, 2000, p.477).

Swan's study (2001) revealed that course content is significantly associated with learning efficiency. For the learning effectiveness of Web-based courses, the educational content must motivate students to learn and come back for more (Werbach, 2000).

However, our questionnaire includes only three dimensions of the course contents. Other dimensions discussed in the literature include examinations, cases, group assignments, etc. as discussed above. The questionnaire we designed includes the overall usability of the course web site (Q30), the logical organization of the course materials (Q20), and the communication of course objectives and procedures (Q19). Our study shows that the overall usability of the course web-site is the second most critical success factor in e-learning system's perceived outcomes, which can explain about 10% of residual variance of the dependent variable. Clearly communicated course objectives and procedures are also perceived to be an important factor to the outcome of e-learning system.

Students' Self-Motivation and EFFORTS

The students' self-motivation is defined as the extent in which students are willing "to monitor, control their behavior by setting goals, using prior knowledge, considering alternative strategies developing a plan of attack, and contingency plans when they run into trouble." (Dembo and Eaton, 2000, p.475) Most students are taking courses online because the online environment offers better access to the courses: travel is reduced and the online environment allows a better fit with work and family responsibilities. Other factors, such as pace of course and learners' control over the course might also motivate

students to choose the online environment. However, it is obvious that students with more motivation will be more successful in Web-based courses than those with less motivation (Frankola, 2001; Hiltz, 1993; LaRose and Whitten, 2000; Leidner and Jarvenpaa, 1995). Graham and Scarborough (2001, p.242) suggest that “students who tend to learn the most with online courses are those who are highly motivated along with the willingness to devote the necessary time to study.”

To assess the level of student’s motivation, we designed two questions asking the amount of efforts they put forth in on-line class (Q33) and whether students are goal-directed or not (Q32). The results of the regression reinforce the findings of Graham and Scarborough that the amount of efforts is strongly associated with perceived learning outcomes.

Bernard, *et al.* identifies three factors of motivation that are related to learning in a collaborative online environment, specifically, computer conferencing. These factors are goal orientation (relating specifically to the reasons for student participation); self-efficacy (the beliefs one holds about themselves); and outcome expressions (the users’ beliefs about usefulness of the computer conferencing system). They then correlated these three factors to two outcome measures of satisfaction and frequency of use. Simply put, their tentative findings suggest that “motivational preparation of learners for online work is desirable, especially when the learners possess low confidence and or skill levels” (Bernard et al 2000, p. 268). Graham and Scarborough (2001, p. 242)generally concluded that students who tend to learn the most with online courses are those that are highly motivated, able to accept change, and are willing to devote the necessary time to study. This seems to be generally applicable to traditional face-to-face courses as well, except that acceptance of change may be less important.

Personality/Learning Style

There has been little research on the relationship between students’ personality/learning style and the learning efficiency. Among the exceptions are studies that found an indirect relationship between students’ personality and learning style (Graham and Scarborough, 2001; Swan, 2001). For instance, in a study that focused on an online macroeconomics course, Graham and Scarborough (2001) suggested that a relationship between student learning style and learning efficiency may exist. Despite the lack of quantitative and qualitative evidence, it is still presumed that student personality and learning style can affect the effectiveness of a Web-based course.

The survey questionnaire includes two questions on this subject. Q34 asks students whether they prefer to express their idea in writing, as opposed to oral expression. Q35 asks students which direction they can understand better – map or oral direction. Model 6 in table 1 indicates that the learning style of students (Q34) may be positively correlated with the perceived e-learning outcomes. The impact is not entirely clear, since only .008% of residual variance can be reduced by adding this variables in the regression model.

Other Factors that May affect the learning outcomes

Although the regression model failed to include the following factors as the critical variables that affects the perceived learning outcomes, there are abundant literature that shows positive association between the learning outcome and interactions among the instructor, and students, and between the students. Interaction has been recognized as the most important and critical construct of the dimensions determining the performance of web-based course quality. Many studies have shown that interaction is highly correlated to the learning effectiveness of Web-based courses and most students who reported higher levels of interaction with content, instructor, and peers reported higher levels of satisfaction and higher levels of learning. (O’Reilly and Newton, 2001; Swan, 2001; Vaverek and Saunders, 1993) In contrast with studies indicating high levels of correlation between interaction and learning effectiveness, some studies warn that too much or too little interaction may cause a negative correlation with learning effectiveness (Berge, 1999).

Arbaugh (2000) concludes that instructor emphasis on interaction is positively associated with student satisfaction. His factor analysis focusing on “instructor emphasis on interaction, which focused on the instructor’s efforts to generate interaction and the outcomes of those interactions” were statistically significant as they loaded at 0.55 or higher, and had a coefficient alpha of 0.82 (Arbaugh, 2000). In contrast, “student use [of interaction] was positively associated with satisfaction, [but] the relationship was not significant”(Arbaugh, 2000; 2000).

Swan concluded “students who had high perceived levels of interaction with the instructor also had high levels of satisfaction with the course and reported higher levels of learning than students who thought they had less interaction with the instructor” (Swan, 2001, p.316). This seems to support the overall body of knowledge that positively links instructor to student interaction with higher levels of satisfaction and perceived learning outcomes. Nevertheless this study failed to establish a link between the outcome and interactions.

CONCLUSIONS

The purpose of this study is to develop a regression model to explain the relationship between the dependent variable (perceived student's learning outcome) and the independent variables (instructor, interaction between student and instructor, student's self-motivation, personality/learning style, student's integration of efforts, and content).

The findings from the step-wise regression model indicate that an instructor's caring attitude is the critical success factor in e-learning systems. The instructor's caring attitude can be translated into many different strategies and tactics in the delivery of instructions in e-learning systems. For example, feedback to the students may be given to the students on an individual basis, instead of posting the uniform answer on the conferencing systems or on the class web pages. An instructor may use customized e-mail to each individual student. There are certainly trade-offs between costs and benefits for doing so. No one will disagree with the notion that the instructor requires much more time to manage on-line courses than traditional face-to-face class. Individual attention approach, needless to say, demands more and more instructors' time in interacting with the students.

A notable conclusion from this study is that the premise that the instructor's role decreases in an online environment appears to bear no weight. We believe that the instructor's input may significantly affect motivation and interaction, which are necessary for online learning to occur.

Student's self-motivation toward Web-based courses has a direct link to the learning outcome of Web-based courses. Higher levels of the students' self-motivation toward Web-based courses affect the level of the learning outcome. Hence, it is recommended that instructors of Web-based courses and Web-based course designers focus on increasing interaction and motivating their students toward Web-based courses.

Our study failed to identify interactions as a critical factor to the success of e-learning system. The importance of interaction in the learning process needs to be analyzed further in future studies. As many researchers before have proven, interaction is a necessary component for online learning just as it is in traditional face-to-face learning environments. Successful online learning has to be more than an individual completing assignments alone and reading materials assigned daily/weekly in a solo setting. Interaction is the pivotal process that facilitates students learning and understanding into a deeper level. Nevertheless, our study does not support that premise.

We have not conclusively proved that a student's personality and learning style should not be included in future causal models, but we have our doubts. None of our data suggested strong correlations between these factors with any other factors in our model. An online student with sufficient motivation will learn regardless of their personality or learning style.

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APPENDIX 1 - SURVEY QUESTIONS

1. The instructor was very knowledgeable about the subject matter of the course.
2. The instructor was actively involved in facilitating (teaching) the course.
3. The instructor provided timely feedback on assignments, exams, or projects.
4. The instructor provided helpful feedback on assignments, exams, or projects.
5. The instructor stimulated students to intellectual effort beyond that required by face-to-face courses.
6. The instructor expected students to take their share of responsibility for learning.
7. I felt as if the instructor cared about my individual learning in this course.
8. The instructor was responsive to student concerns.
9. I would recommend this instructor to other students.
10. The course objectives and procedures were clearly communicated.
11. The course material was organized into logical and understandable components.
12. My interest in the subject matter was stimulated.
13. Keeping in mind the amount of time and effort that you put into on-campus courses including in class time, the workload was appropriate for the course.
14. The academic quality was on par with face-to-face courses I've taken.
15. I frequently interacted with other students in this on-line course.
16. I frequently interacted with the instructor in this on-line course.
17. I would recommend this course to other students.
18. The overall usability of the course Web site was good.
19. I feel that I have learned as much from this course as I might have from a face-to-face version of the course.
20. I am goal directed; if I set my sights on a result, I usually can achieve it.
21. I put forth the same effort in the on-line course as I would in a face-to-face course.
22. I prefer to express my ideas and thoughts in writing, as opposed to oral expression.
23. I understand directions better when I see a map than when I receive oral directions.
24. I feel that I learn more in on-line courses than in face-to-face courses.
25. The quality of the learning experience in on-line courses is better than in face-to-face courses.
26. I would take an on-line course again in the future.

Each question is Likert-type -scaled multiple choice question with the range of the following values:

Disagree strongly

Disagree

Neither agree nor disagree

Agree

Agree strongly